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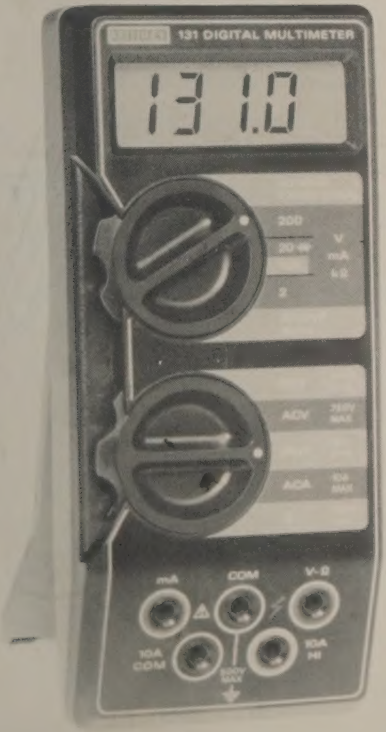
KEITHLEY

Model 131
Digital Multimeter
Instruction Manual



Publication Date: October 1982
Document Number: 32433

WARRANTY

We warrant each of our products to be free from defects in material and workmanship. Our obligation under this warranty is to repair or replace, at our option, any instrument thereof which, within a year from date of shipment, proves defective upon examination. We will pay local domestic surface freight costs. (NOTE: This warranty does not cover battery replacement or damage due to battery leakage.)

SERVICE POLICY

For service on your Model 131 Digital Multimeter, contact your local Keithley representative who will be able to give you immediate assistance in most cases. Complete repair and calibration facilities are maintained in the United States, West Germany, Great Britain, France, the Netherlands, Switzerland, and Austria. Information concerning the application, operation or service of your instrument may be directed to the applications engineer at any of the above locations.

SAFETY SYMBOLS AND TERMS

The symbol denotes that the user should refer to the operating instructions.

The symbol denotes that a high voltage may be present on the terminal(s).

The **WARNING** used in this manual explains dangers that could result in personal injury or death.

The **CAUTION** used in this manual explains hazards that could damage the instrument.

SPECIFICATIONS

DC VOLTS

RANGE	RESOLUTION	ACCURACY (1 YEAR) ±(%rdg + digits) 18°-28°C
200mV	100 μV	
2 V	1mV	
20 V	10mV	±(0.25% + 1d)
200 V	100mV	
1000 V	1 V	

MAXIMUM ALLOWABLE INPUT: 1000V DC or peak AC non-switched, 750V peak switched.

INPUT RESISTANCE: 10MΩ.

NORMAL MODE REJECTION RATIO: Greater than 46dB at 50Hz, 60Hz.

COMMON MODE REJECTION RATIO: Greater than 100dB at DC, 50Hz and 60Hz (1kΩ unbalance).

AC VOLTS

RANGE	RESOLUTION	ACCURACY (1 YEAR)* ±(%rdg + digits) 18°-28°C	FREQUENCY RANGE
200mV	100 μV		45Hz-500Hz
2 V	1mV		45Hz-500Hz
20 V	10mV	±(1% + 3d)	45Hz-500Hz
200 V	100mV		45Hz-500Hz
750 V	1 V		45Hz-500Hz

*Above 10 counts.

MAXIMUM ALLOWABLE INPUT: 1000V peak non-switched, 750V peak switched; continuous except 200mV range: 15s max above 300V.

INPUT IMPEDANCE: 10MΩ shunted by less than 100pF.

RESPONSE: Average responding, calibrated in rms of a sine wave.

OHMS

RANGE	RESOLUTION	ACCURACY (1 YEAR) ±(%rdg + digits) 18°-28°C	FULL SCALE VOLTAGE
200 Ω	100mΩ	±(0.5% + 4d)	×0.5V
2 kΩ	1 Ω	±(0.2% + 1d)	×0.5V
20 kΩ	10 Ω	±(0.2% + 1d)	×0.7V
200 kΩ	100 Ω	±(0.2% + 1d)	×0.7V
20MΩ	10 kΩ	±(2 % + 1d)	×0.7V

MAXIMUM OPEN CIRCUIT VOLTAGE: 1.5V.

MAXIMUM ALLOWABLE INPUT: 300V DC or rms.

DC AMPS

RANGE	RESOLUTION	ACCURACY (1 YEAR) ±(%rdg + digits) 18°-28°C	MAXIMUM FULL SCALE VOLTAGE BURDEN
2mA	1 μA	±(0.75% + 1d)	0.25V
20mA	10 μA	±(0.75% + 1d)	0.25V
200mA	100 μA	±(0.75% + 1d)	0.25V
2000mA	1mA	±(2 % + 1d)	0.7 V
10 A	10mA	±(2 % + 1d)	0.3 V

OVERLOAD PROTECTION: mA input: 2A fuse (250V), externally accessible; 10A input: 20A for 15s unfused.

AC AMPS

RANGE	RESOLUTION	ACCURACY (1 YEAR) ±(%rdg + digits) 18°-28°C (45Hz-500Hz)	MAXIMUM FULL SCALE VOLTAGE BURDEN
2mA	1 μA	±(2% + 2d)	0.25V
20mA	10 μA	±(2% + 2d)	0.25V
200mA	100 μA	±(2% + 2d)	0.25V
2000mA	1mA	±(3% + 5d)	0.7 V
10 A	10mA	±(3% + 5d)	0.3 V

OVERLOAD PROTECTION: mA input: 2A fuse (250V), externally accessible; 10A input: 20A for 15s unfused.

GENERAL

DISPLAY: 3½ digit LCD, 0.6" height, with polarity and range indications.

OVERRANGE INDICATION: 3 least significant digits blanked.

MAXIMUM COMMON MODE VOLTAGE: 500V peak.

OPERATING ENVIRONMENT: 0° to 50°C

STORAGE ENVIRONMENT: −35°C to 60°C.

TEMPERATURE COEFFICIENT (0° to 18°C and 28° to 50°): Less than 0.1 × applicable accuracy specification per °C.

POWER: 9V alkaline or carbon-zinc battery (NEDA 1604).

BATTERY LIFE: 100 hours typical with carbon-zinc cells, 200 hours with alkaline cells.

BATTERY INDICATOR: Display indicates BAT when less than 10% of life remains.

DIMENSIONS, WEIGHT: 178mm long × 78mm wide × 38mm thick (7.1" × 3.1" × 1.5"). Net weight 283gm (10 oz.).

ACCESSORIES SUPPLIED: Battery, test leads and operating instructions.

Specifications subject to change without notice.

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GENERAL INFORMATION

The Model 131 Digital Multimeter is supplied ready for use with a battery. Descriptions of other available accessories, and other general information concerning the instrument can be found below.

MANUAL ADDENDA

Information contained in this manual is believed to be accurate at the time of printing. Any improvements or changes to this manual will be documented in an addendum which will be included with the instrument.

OPTIONAL ACCESSORIES

Model 1301 Temperature Probe is a rugged low cost temperature probe designed to allow precision temperature measurement from −55°C to 150°C.

Model 1304 Soft Carrying Case and Stand

Model 1306 Deluxe Case is a rugged DMM carrying case that is large enough to accommodate the Model 131 plus various other DMM articles such as a spare battery, test leads, etc.

Model 1309 Spare Parts Kit is a collection of specially selected parts to maintain up to ten Model 131 DMMs for one year.

Model 1600A High Voltage Probe extends the DMM to 40kV. It has a 1000:1 division ratio, which means that 1V on the DMM corresponds to 1kV.

Model 1651 50-Ampere Shunt allows current measurements to be made up to 50-amperes. It is a 0.001Ω ±1% 4-terminal shunt. When the DMM is set to the 2V range, a 50-ampere current will correspond to 50mV (.0500V).

Model 1681 Clip-On Test Lead Set contains two leads, 1.2m (48 inches) long, terminated with banana plug and spring action clip-on probe.

Model 1682A RF Probe allows voltage measurements from 100kHz to 250MHz.

Model 1683 Universal Test Lead Kit consists of two test leads, 1.2m (48 inches) long with 12 screw-in tips—2 banana plugs, 2 spade lugs, 2 alligator clips with boots, 2 needle tips with chucks and 4 heavy-duty tip plugs.

Model 1685 Clamp-On AC Current Probe measures AC current by clamping onto a single conductor. Interruption of the current path is unnecessary. The Model 1685 detects current by sensing magnetic field produced by current.

Model 1691 General Purpose Test Lead Set consists of two .91m (36 inches) test leads with probe tips terminated in banana plugs.

PREPARATION FOR USE

Carefully unpack the Model 131 from its shipping carton and inspect for any obvious signs of physical damage. Report any damage to the shipping agent at once. The following items are included with every Model 131 shipment.

1. Model 131 DMM
2. Model 131 Instruction Manual
3. 9V Battery NEDA 1604
4. Test Leads
5. Accessories as ordered.

BATTERY INSTALLATION/REPLACEMENT

The battery is accessible from the bottom of the instrument. Note the precautions on the case before installing or replacing the battery.

WARNING

Turn the Model 131 off and disconnect test leads before replacing the battery. Put the cover back into place on the compartment before resuming use of the instrument.

A 9V battery is supplied with the instrument but not installed. To install or replace the battery, remove the cover from the battery compartment by sliding it off in the direction of the arrow located on the battery cover. The battery connector snaps on and off the terminal of the battery. Improper installation of the battery will cause the connecting wires to be severed by excess strain. Proper installation requires that the battery be positioned in such a manner (see drawing) that the leads protruding from the boot of the battery connector face toward the outside of the battery compartment. If the instrument is going to be stored for a long period of time or in a high temperature environment, remove the battery to prevent leakage damage.

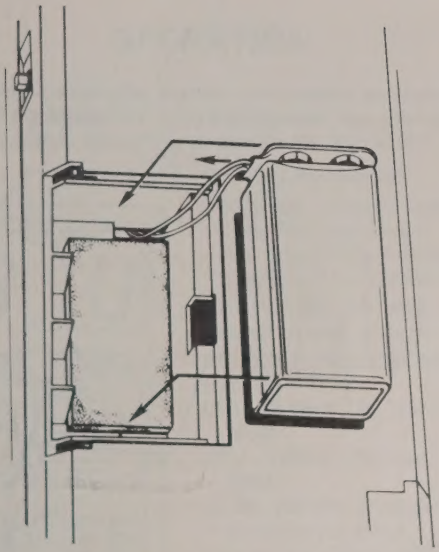
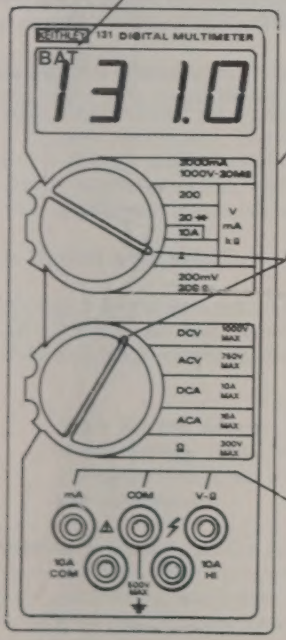


Figure 1. Battery Installation

OPERATION

The following paragraphs contain information concerning basic operation of the Model 131. It is recommended that this information be reviewed before attempting to operate the Model 131.



Low Battery Indicator.

Minus sign indicates negative values. Plus sign implied. An over range condition is indicated by a "1" followed by a blank display.

SET POWER ON (slide switch located on side of instrument).

SELECT FUNCTION AND RANGE

DCV—200mV, 2V, 20V, 200V or 1000V

ACV—200mV, 2V, 20V, 200V or 1000V

NOTE: 750VAC is maximum allowable AC input.

DCA—2mA, 20mA, 200mA, 2000mA or 10A

ACA—2mA, 20mA, 200mA, 2000mA or 10A

Ω—200Ω, 2kΩ, 20kΩ, 200kΩ or 20MΩ

INPUTS—Select appropriate pair of input jacks.

COM, V-Ω—for all voltage and resistance measurements.

COM, mA—for current measurements up to 2000mA.

10A COM, 10A HI—for current measurements up to 10A.

Figure 2. Front Panel Controls

CAUTION

Do not under any circumstances, use the 10A COM or 10A HI input jacks with the COM input jack for making measurements. This is a short and will damage the instrument.

SAFETY PRECAUTIONS

1. Do not exceed the instrument's maximum allowable input as defined in the specifications.
2. Do not apply more than 500V peak above earth ground to the COM input jack.
3. Exercise extreme caution when a shock hazard is present at its input. The American National Standard Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V rms or 42.4V peak are present.
4. A good safety practice is to expect that hazardous voltages are present in any unknown circuit to be measured, until actual conditions are verified.

SERVICING INFORMATION

This section contains servicing information for the Model 131.

WARNING

All service information is intended for qualified electronic maintenance personnel only.

FUSE CHECK

With the instrument set to the 2kΩ range, connect a jumper from the V-Ω jack to the mA jack. The display should read approximately .100. An overrange display would typically indicate a blown fuse. A display reading other than approximately .100 could indicate a defective current input circuit (see schematic).

FUSE REPLACEMENT

A 2-amp fuse protects the 2mA through 2000mA current ranges. To gain access to the fuse, remove the fuse compartment cover in the same manner as removing the battery compartment cover.

WARNING

Turn off the Model 131 and disconnect the test leads before replacing the fuse. Reinstall fuse compartment cover before attempting to operate the instrument.

Remove the fuse by pulling outward on the plastic tab the encircles the fuse body. Install the plastic tab on the new fuse and snap the fuse back into the fuse holder. Do not replace the fuse with a higher rated value or instrument damage that is not covered by the warranty may occur.

DIODE TEST

The 20kΩ range can be used for testing of semiconductor junctions. A junction is probably good if the Model 131 indicates an overrange reading when the semiconductor is reversed biased, and an on-range reading, when the semiconductor is forward biased. (The V-Ω jack is positive.)

DISASSEMBLY INSTRUCTIONS

Place the unit face down on a bench or other similar surface and remove the battery compartment cover. Disconnect and remove the battery. Remove the two #4-40 × 7/8 retaining screws.

Grasp the bottom cover at the input jack end and with a lifting and forward pushing motion (see drawing), carefully remove the bottom cover. While removing the cover, feed the battery connector through the access hole in the bottom of the battery compartment.

The component side of the PC board is now exposed and the battery can be reconnected for troubleshooting. To read the display, some light downward pressure at the top end of the circuit board may be required in order to make contact through the elastomer contact strip between the circuit board and the LCD.

The PC board and LCD assembly are not secured once the case retaining screws are removed. Be careful not to allow the PC board and LCD assembly to fall out or shift out of position during calibration.

To remove the PC board from the top cover, grasp the function switch assembly and lift until the input jacks become disengaged from the cover. The PC board can now be removed using a slight clockwise motion to free the two switch knobs from their normal positions in the case.

The LCD assembly will remain in the top cover when the PC board is removed. Again, be careful not to allow the LCD assembly to fall out accidentlly.

The two switch knobs and bushings can be removed from the PC board assembly by simply pulling them off the switch shafts.

The LCD assembly, along with the zebra strip connector, lifts out of the case.

To reassemble the Model 131, remove the cover on the fuse compartment (to position fuse pulling tab) and reverse the above procedures.

WARNING

Be sure to replace the on-off switch cover. Common-mode voltage will be present on the

switch, creating a possible hazard if the cover is not replaced.

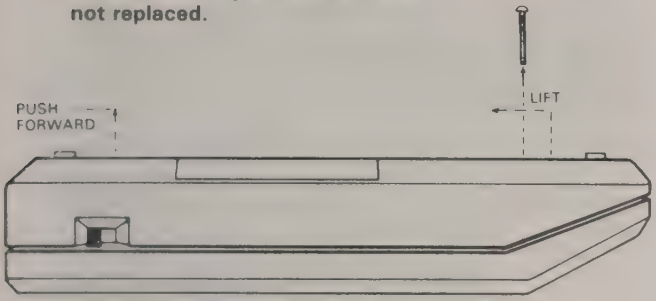


Figure 3. Rear Panel Removal

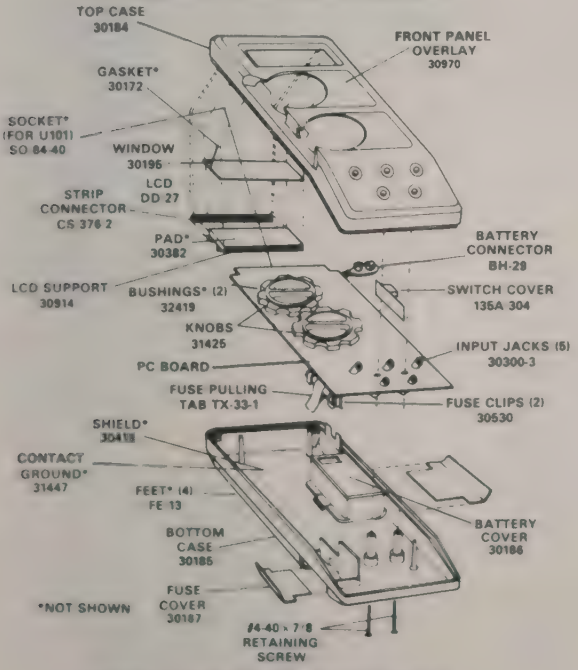


Figure 4. Model 131 Exploded View

CALIBRATION

Calibration should be performed yearly or whenever the instrument is known to be out of specification. Calibration should be done at an ambient temperature of 25° ±3°C (77° ±5°F), with a relative humidity of less than 80%.

Equipment Needed: +190mV DC voltage source with .05% accuracy or better.
Model 131 Settings: DCV function, 200mV range, V-Ω and COM input jacks.

CALIBRATION PROCEDURE

Remove the battery cover to gain access to the calibration pot R103 (see Figure 1). Apply the +190mV to the Model 131 input and adjust R103 for a display reading of 190.0 ±1 digit. This is the only adjustment needed to calibrate the instrument. Calibration should be performed yearly.

MODEL 131 PARTS LIST

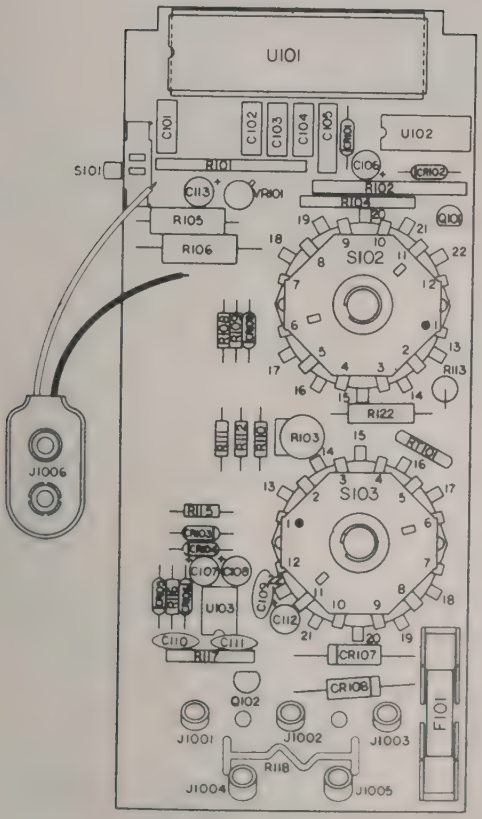
Circuit Desig.	Description	Schematic Location	Keithley Part No.
BT101	Battery, 9V, NEDA 1604	C4	BA-14
C101	Cap, 110pF, 500V, Mica	H3	C-320-110P
C102	Cap, .047μF, 100V, Polyester	F3	C-305-.047
C103	Cap, .047μF, 100V, Polyester	E4	C-305-.047
C104	Cap, .1μF, 100V, Polyester	G3	C-305-.1
C105	Cap, .1μF, 160V, Polypropylene	G3	C-306-.1
C106	Cap, 1.5μF, 20V, Tantalum	D4	C-314-1.5
C107	Cap, 4.7μF, 20V, Tantalum	D2	C-314-4.7
C108	Cap, 1.5μF, 20V, Tantalum	D4	C-314-1.5
C109	Cap, .02μF, 1000V, Ceramic Disc	C2	C-316-.02
C110	Cap, .1μF, 50V, Ceramic	C2	C-238-.1
C111	Cap, .1μF, 50V, Ceramic	D2	C-238-.1
C112	Cap, 1μF, 20V, Tantalum	D2	C-325-1
C113	Cap, 4.7μF, 20V, Tantalum	F1	C-314-4.7
CR101	Rectifier, 1A, 800V	C4	RF-38
CR102	Rectifier, 75mA 75V	C6	RF-28
CR103	Rectifier, 75mA, 75V	C2	RF-28
CR104	Rectifier, 75mA, 75V	C2	RF-28
CR105	Rectifier, 75mA, 75V	D2	RF-28
CR106	Rectifier, 75mA, 75V	D2	RF-28
CR107	Rectifier, 3A, 50V	A4	RF-34
CR108	Rectifier, 3A, 50V	B4	RF-34
CR109	Rectifier, 75mA, 75V	B3	RF-28
DS101	Liquid Crystal Display	G5	DD-27
	Connector, Strip	—	CS-376-2
F101	Fuse, 2A, 250V, 3AG, USA Models	A4	FU-13
J1001	Jack, Input	A1	30300-3
J1002	Jack, Input	A4	30300-3
J1003	Jack, Input	A4	30300-3
J1004	Jack, Input	B5	30300-3
J1005	Jack, Input	B5	30300-3
J1006	Connector, Battery	C4	BH-29
Q101	Transistor, NPN, Switch, 2N3904	E5	TG-47
Q102	Transistor, NPN, Silicon, GES5818	E3	TG-138
R101	Thick Film Resistor Network	SEV	TF-97
R102	Thick Film Resistor Network	SEV	TF-119
R103	Pot, 500Ω	G2	RP-119-500
R104	Thick Film Resistor Network	B3, B4	TF-94
R105	Resistor, 1MΩ, 10%, 1W, Comp	E4	R-2-1M
R106	Resistor, .1Ω, .5%, 1W, WW	B4	R-279-.1
R107	NOT USED		

MODEL 131 PARTS LIST (CONT.)

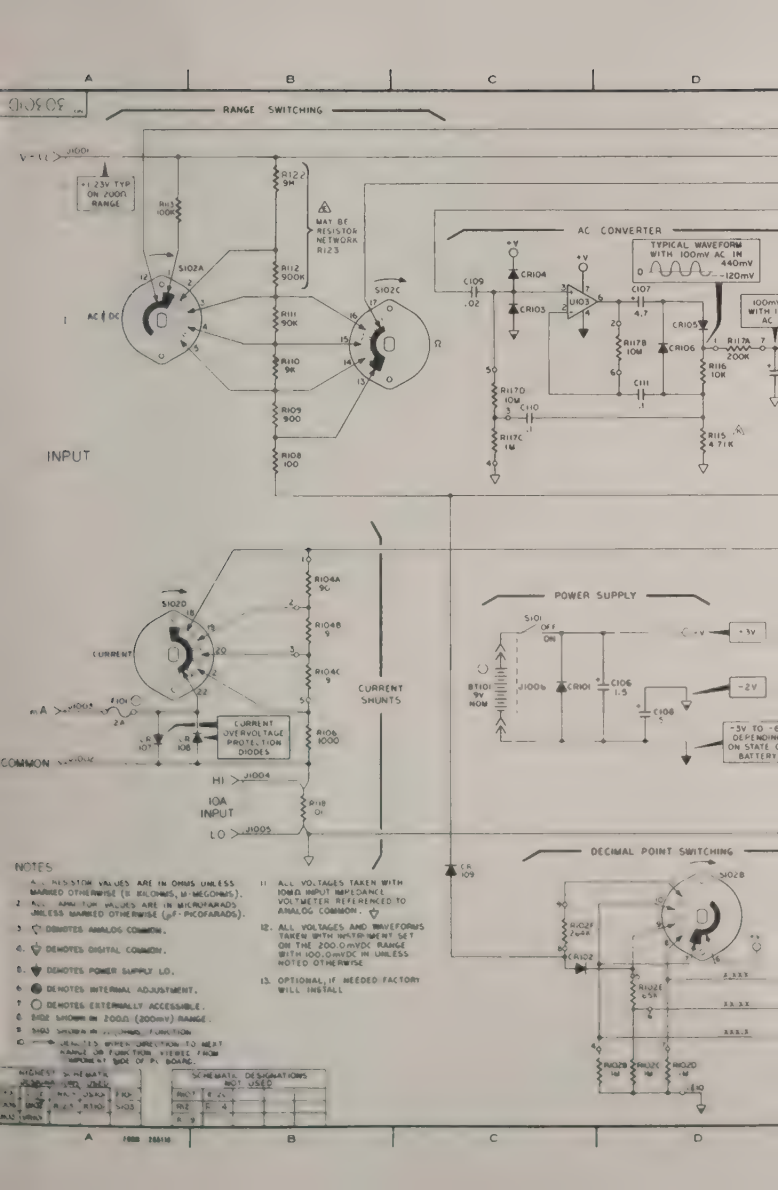
Circuit Desig.	Description	Schematic Location	Keithley Part No.
R108	Resistor, 100Ω, .1%, 1/10W, MtF	B3	R-283-100
R109	Resistor, 900Ω, .1%, 1/10W, MtF	B2	R-283-900
R110	Resistor, 9kΩ, .1%, 1/10W, MtF	B2	R-283-9k
R111	Resistor, 90kΩ, .1%, 1/10W, MtF	B2	R-283-90k
R112*	Resistor, 900kΩ, .1%, 1/10W, MtF	B2	R-283-900k
R113	Resistor, 100kΩ, 10%, 1W, Comp	C1	R-2-100k
R114	NOT USED		
R115	Resistor, 4.72kΩ, .1%, 1/10W, MtF	D3	R-283-4.72k
R116	Resistor, 10kΩ, .1%, 1/10W, MtF	D2	R-283-10k
R117	Thick Film Resistor Network	SEV	TF-96
R118	Resistor, 0.01Ω, 0.5%, 1W, WW	B5	R-280-.01
R119	NOT USED		
R120	NOT USED		
R121	NOT USED		
R122*	Resistor, 9MΩ, .08%, 2W	B1	R-281-9M
R123*	Thick Film Resistor Network	B1	TF-104
RT101	Thermistor, 8mA, 500V, PTC	E2	RT-7
S101	Switch, SPDT, ON-OFF	C4	SW-417
S102	Switch, Rotary, Range	SEV	SW-432
S103	Switch, Rotary, Function	E2, F2	SW-433
U101	3½-Digit Single Chip A/D Converter	G4	LSI-22
U102	CMOS Quad Exclusive OR Gate	F5, F6	30847
U103	Low-Power JFet-Input OP-Amp	C2	IC-227
VR101	Diode, Low Voltage Reference	G1	DZ-62

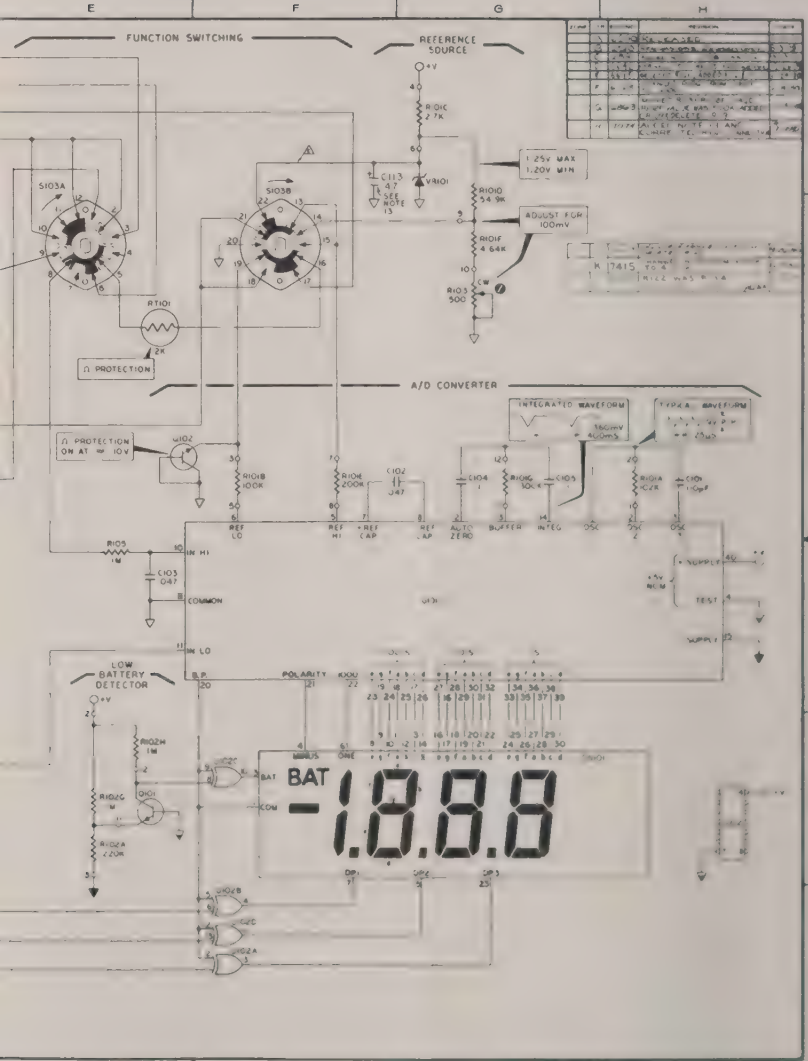
*See alternate configuration on component layout.

COMPONENT LAYOUT



ALTERNATE CONFIGURATION


RANGE SWITCHING
AC CONVERTER
POWER SUPPLY
DECIMAL POINT SWITCHING
INPUT
CURRENT SHUNTS
10A INPUT
HI
LO
COMMON
CURRENT OVERVOLTAGE PROTECTION DIODES
MAY BE RESISTOR NETWORK R123
TYPICAL WAVEFORM WITH 100mV AC IN
440mV
120mV
ON
OFF
NOTES
1. ALL RESISTOR VALUES ARE IN OHMS UNLESS MARKED OTHERWISE (K KILOHMS, M MEGOHMS).
2. ALL CAPACITOR VALUES ARE IN MICROFARADS UNLESS MARKED OTHERWISE (pF PICOFARADS).
3. DENOTES ANALOG COMMON.
4. DENOTES DIGITAL COMMON.
5. DENOTES POWER SUPPLY LO.
6. DENOTES INTERNAL ADJUSTMENT.
7. DENOTES EXTERNALLY ACCESSIBLE.
8. RIDE SHOWN IN 200Ω (200mV) RANGE.
9. SHOWN SWITCH FUNCTION
10. ARROW INDICATES DIRECTION TO NEXT RANGE OR FUNCTION WHEN VIEWED FROM OPPOSITE SIDE OF P.C. BOARD.
11. ALL VOLTAGES TAKEN WITH 10MΩ INPUT IMPEDANCE VOLTMETER REFERENCED TO ANALOG COMMON.
12. ALL VOLTAGES AND WAVEFORMS TAKEN WITH INSTRUMENT SET ON THE 200.0mVDC RANGE WITH 100.0mVDC IN UNLESS NOTED OTHERWISE
13. OPTIONAL, IF NEEDED FACTORY WILL INSTALL
SCHEMATIC DESIGNATIONS NOT USED


E
F
G
H
FUNCTION SWITCHING
REFERENCE SOURCE
+V
R10IC 2.7K
R10IO 54.9K
R10IF 4.64K
R103 500
CW
1.25V MAX 1.20V MIN
ADJUST FOR 100mV
C113 4.7 SEE NOTE 13
VR101
S103A
S103B
R101 2K
Ω PROTECTION
A/D CONVERTER
INTEGRATED WAVEFORM
TYPICAL WAVEFORM
Ω PROTECTION ON AT 10V
Q102
R10IB 100K
R10IE 200K
C102 0.47
C104
R10IG 50K
C105
R10IA 2K
C101 100pF
REF LO
REF HI
+REF CAP
-REF CAP
AUTO ZERO
BUFFER
INTEG
OSC
R105 1M
C103 0.47
IN HI
COMMON
IN LO
+SUPPLY
+5V REM
TEST
-SUPPLY
LOW BATTERY DETECTOR
B.P.
POLARITY
KKOU
MINUS
ONE
BAT
COM
R102M 1M
R102G 1M
R102A 220K
Q101
U102B
U102C
U102A
BAT
-1.8.8.8
DP1
DP2
DP3

KEITHLEY

SERVICE FORM

Model No. _____ **Serial No.** _____ **P.O. No.** _____ **Date** _____

Name _____ **Phone** _____

Company _____

Address _____

City _____ **State** _____ **Zip** _____

List all control settings and describe problem. _____

_____

_____

_____ (Attach additional sheets as necessary.)

Show a block diagram of your measurement system including all instruments connected (whether power is turned on or not). Also describe signal source.

Where is the measurement being performed? (factory, controlled laboratory, out-of-doors, etc.) _____

What power line voltage is used? _____ Variation? _____

Frequency? _____ Ambient Temperature? _____ °F.

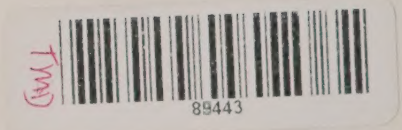
Variation? _____ °F. Rel. Humidity? _____ Other? _____

Any additional information. (If special modifications have been made by the user, please describe below.)

_____

_____

*Be sure to include your name and phone number on this service form.



KEITHLEY

Keithley Instruments, Inc./28775 Aurora Road/Cleveland, Ohio 44139/U.S.A./(216) 248-0400/Telex: 98-5469
WEST GERMANY: Keithley Instruments GmbH/Heiglhofstrasse 5/D-8000 München 70/(089) 714-40-65/Telex: 521 21 60
GREAT BRITAIN: Keithley Instruments, Ltd./1, Boulton Road/Reading, Berkshire RG2 ONL/(0734) 86 12 87/Telex: 847047
FRANCE: Keithley Instruments SARL/2 Bis, Rue Léon Blum/B.P. 60/91121 Palaiseau Cedex/(6) 011.51.55/Telex: 600933F
NETHERLANDS: Keithley Instruments BV/Arkelsedijk 4/NL-4206 AC Gorinchem/(01830) 25577/Telex: 24 684
SWITZERLAND: Keithley Instruments SA/Kriesbachstr. 4/CH-8600 Dübendorf/01 821 94 44/Telex: 57 536
AUSTRIA: Keithley Instruments Ges.m.b.H./Döblinger Hauptstr. 32/A-1190 Wien/0222 314 289/Telex: 13 45 00
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